

The Application Research of Basalt Fiber in Technical Non-woven Fabrics

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Abstract: The application of the basalt fiber has been received much more attention in many fields, due to its excellent mechanical, anti-high temperature and chemical properties, and high ratio of mechanical property / price. With the increasing application of technical non-woven fabrics, the application research of the basalt fiber in technical non-woven fabrics become a research hotspot. This paper reviews the application field and progress of application research of basalt fiber in technical non-woven fabrics and propose technical basalt fiber non-woven fabrics has a broad market prospect.

some advices to the application development of basalt fiber and BFRP.

Keywords: basalt fiber non-woven fabrics needled felt surfacing mat geotextile

1. Introduction

Continuous basalt fiber belongs to a new high-tech fiber. It's a kind of inorganic fibers, whose raw material is only basalt rock, melted under temperature as high as 1500°C and drawn continuously to fibers. It is six to seven years industrialized developing history. There are many outstanding performances, such as high strength & modulus, acid & alkali resistance, high & low temperature resistance (-269~+650°C), fireproofing & fire resistance, ultraviolet irradiation resistance, non hygroscopic, electrical insulation, etc.^[1](Table 1). Because of these good properties, basalt fiber is widely applied in several national economy industrial fields, including construction, environmental protection, fire protection, automobile & ships manufacture, traffic & infrastructure construction, oil & gas, aerospace, and so on.

Nonwoven industry is considered as 21 century's sunrise industry. Nonwoven, as an important fabric, is extensively used in construction, medical treatment, environmental protection, clothing, automobile, aerospace, and such fields. In recent years, along with rapid growth of nonwoven fabric demand, as well as its technical production development, the main characteristic of nonwoven fabric is permeating through high & new technology and new materials using. High-tech fibers are more and more used in nonwoven fabric industries, promoting to widen the application fields of nonwoven fabrics, which provides innovative opportunity for basalt fiber to apply in the field of nonwoven fabrics.

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Table 1 Main technical data of basalt fiber

No.	Performance Index	Value
1	Thermal physical properties	
	Working temperature (°C)	-269~650
	Softening temperature (°C)	1050
	Thermal conductivity (w/m.°K)	0.03~0.038
2	Physical properties	
	Density (g/cm ³)	2.63~2.65
	Elastic modulus (GPa)	91~110
	Tensile strength (MPa)	3000~4800
	Tensile strength under thermal treatment (%)	
	20 °C	100
	200 °C	95
	400 °C	82
3	Chemical stability (weight loss after 3 hours' boiling %)	
	2N HCl	2.2
	2N NaOH	6.0
	H ₂ O	0.2
4	Electrical property	
	Specific capacity resistance (Ω.M)	1×10 ¹²
	Dielectric absorption tetrahedral angle(1M Gs of frequency)	0.005
	Permittivity (1M Gs of frequency)	2.2
5	Acoustical property*	
	Acoustic absorptivity	0.9~0.99

2.

Basalt fiber applied in nonwoven fabric industry

(1) Filter material

Nonwoven fabric filter material focuses on basalt fiber needled felt (Picture 1). This kind of material has many advantages, such as unique three-dimensional network structure, evenly distributed pores, good filtering property, low cost, etc. It is mainly used in the field of high temperature flue gas filtering, including black carbon, steel, non-ferrous metal, chemical industry, incineration, and so on. At present, the heat resistance of filter material in high-temperature filtering field is generally under 250°C. Some organic fibers, like P84, PPS and aramid fiber, are unable to satisfy the actual requirement under working conditions for filter, since the flue gas from black carbon, steel, non-ferrous metal, chemical industry and incineration has high temperature, acidiferous and alkaliferous materials. For this reason, it has been blank from 250 to 450°C for high-temperature flue gas removal filter. However, basalt fiber will be possible to fill in this range, because of its good thermal endurance (-269~650°C). Simultaneously, it also is a high-quality material for filtering high-temperature corrosive gas, smoke stratification and corrosive liquid, because of its acid assistance, alkali resistance and water resistance property. As carbon fiber, glass fiber and other

inorganic fibers, basalt fiber also belongs to fragile fiber; there are still problems as filter material now. For example, because of low inflection resistance and fiber cohesion, basalt fiber is obviously not as good as synthetic fibers with ductile property. But through surface treatment technology and mixing with ductile fibers, these weaknesses can be improved.



Picture 1 Basalt fiber needled felt

Albarrie Company in Canada, specialized in dust collection environmental protection industry for 30 years, has been used basalt fiber as base fabric of dust bag for 15years. They are still planning to develop new products in the field of high-temperature flue gas filter using basalt fiber. Nebraska Power Sheldon Station in America has researched basalt fiber compound filter bags. Breaking strength loss rates of materials working for 32 months under 190°C have been listed in table 2. From the result, the strength of filter bag with high-temperature synthetic fibers lossed 20~30%, meanwhile, that of basalt fiber nearly remained the same, which indicated better thermal endurance for basalt fiber.

Table 2 Breaking strength test result

Product name	2000.6 (psi)	2002.10 (psi)	Strength addition/loss %
Basalt/P84	900	913	0
P84/P84	547	410	-25
Ryton/ Ryton	532	360	-32
Ryton woven fabric	499	375	-25
Ryton/ Rastex	530	431	-19

Now, the biggest basalt fiber manufacturer in China is Zhejiang GBF Basalt Fiber CO., LTD, located in Hengdian, Dongyang city, Zhejiang Province. Cooperating with one of Japanese biggest high-temperature filter material company, they research and develop basalt fiber application in high-temperature filter material field. This Japanese company made filter material with glass fiber, whose filter material thermal endurance is below 270°C, which couldn't satisfy the request in some certain fields. Now, they change glass fiber to basalt fiber in this field below 270°C. The preliminary test has been approved by this company. They are developing application technology. If it is industrialized, it will be very good for energy saving and emission reduction globally.

(2) Thermal insulation material

Basalt fiber is nonflammable, high-temperature resistance (maximum temperature can be 650°C), low thermal conductivity (0.03~0.038 w/m.°K). Thus basalt fiber needled felt products own good thermal insulation performance, which can be used in thermal insulation of heat devices in pipeline, and also in noise reduction & dust catcher of automobile and motorcycle. Sound absorption, thermal insulation, shock absorption and antinflaming properties also make basalt fiber apply in roof and door cushion of automobile, train and naval vessels, hood (adhere to inner side), baffle between engine carriages and cushion of trunk.

At present, DBW, an automobile manufacturer in Germany, use basalt fiber needled felt as silencer with 20tons per year. America has also been researching in this market. As technical progress, the dosage of basalt fiber needled felt used in automobile silencer will be more and more, that will be definitely a huge market prospect.

(3) Wet process mat

1) Surface mat

The main raw materials of surface mat are basalt fiber chopped strand or basalt fiber with other fibers chopped strand, through paper technology (picture 3). Basalt fiber surface mat has many good properties, such as fibers homodisperse, good processing performance & surfacing, dimensional stability, fast resin impregnation speed, fine spreadability, high strength and corrosion resistance. Compounding with resin, this kind of composite has bright and smooth surface, as well as improve shear strength among interlaminars, weather & water resistance, and corrosion resistance ability. It is widely used in pipeline, construction, bathroom, automobile & ship, and environmental protection. Presently, a Japanese company is researching a kind of automobile house with basalt fiber surface mat. They tested it, and had results as table 3, which indicated that mechanical property of basalt fiber surface mat was better than that with fiber glass. It refers to be a wide automobile market using basalt fiber surface mat.



Picture 3 Basalt fiber surface mat

Table 3 Performance between basalt fiber and glass fiber

Performance		index		
		Basalt fiber		Glass fiber
Areal density (g/m ²)		40	100	45
Filament diameter (μm)		11	11	13
thickness (mm)		0.33	0.76	0.325
Tensile strength (N) (kgf)	Longitudinal	49.3 (5.0)	67.3 (6.9)	(3.2)
	Transversal	39.7 (4.1)	21.1 (2.2)	(1.3)
Elongation (%)	Longitudinal	1	1	-
	Transversal	1	1	-
Tearing strength (N) (kgf)	Longitudinal	2.0 (0.2)	4.6 (0.5)	
	Transversal	1.2 (0.1)	3.0 (0.3)	

2) Reinforced thermoplastic composites

Azdel Company^[4] in USA, produced a new glass fiber reinforced foam polypropylene thermoplastic composite with wet paper technology, named SuperliteAzdel Sheet. It is a kind of mat sheets. Compared with traditional glass fiber reinforced polypropylene composites, this material is thinner and lighter. Its areal weight is around 1/10 of common composites'. In this technology, foam replaces water, used in traditional pulp, which forces glass fiber more even distribution, and sheet more loosen. So it is able to apply in automobile roof lining, body floor, back wallboard, boot floor, fender apron, agricultural implements, recreation facilities and medical equipments. Azdel Company can produce various functions of SuperliteAzdel sheets, through adjusting process parameters and control end product relative density. Recently, this Company has been using this technology in developing basalt fiber reinforced polypropylene composites (picture 4). This composite is going to apply in automobile, heavy truck, construction & agricultural & industrial vehicles.



Picture 4 Basalt fiber reinforced polypropylene thermal plasticity composites mat and sample

(4) Basalt fiber geotextile

Non woven basalt fiber geotextile is mainly made by basalt short fibers, via opening, carding, mixing, lapping and needling. It has outstanding water permeability, durability, anti-aging, high strength, good elongation and filterableness, as well as good mechanical properties, such as tensile strength, tearing strength and bursting strength. It is mainly used in subgrade strengthening, isolation, inverted filtering and drainage, also widely in sports venues, levees, hydraulic structure, tunnel, coastal shoals, reclamation project, refuse processing plant, high way and rail way.

Developing geotextile hybrid fibers with basalt fiber and organic fibers is an important direction. Over the past two years, “GBF basalt fiber reinforced polyester anti-cracking geotextile” has been developed by Traffic Institution of Southeast University, cooperated with Zhejiang GBF Basalt Fiber CO., LTD. This kind of geotextile is a composite compounded with basalt fiber and polyester fiber. The main characteristic centralizes high strength & durability from basalt fiber and flexibility from polyester fiber. Because of good oil-absorption, this kind of hybrid fiber geotextile can form a superior structure lay when speedily absorbed asphalt. Then the product is water-proof, heatproof, corrosion resistant, low expansion coefficient, high-temperature & ultralow temperature resistant. It conquers the long-term creep property from pure polyester fiber geotextile. In addition, it also has good anti-permeability, and can improve working temperature of modified asphalt concrete, prevent & delay radial cracks happening, recycle, and reuse old pavement smash. Under high temperature condition, composite layers are formed when hybrid fiber geotextile compounds with asphalt. This is able to greatly improve the high-temperature resistance, low-temperature resistance, crack resistance, fatigue resistance and uvioresistant

property of bituminous pavement, all of which could extend its service life.

GBF basalt fiber reinforced polyester anti-cracking geotextile can be applied in following fields: 1) old asphalt highway maintenance; 2) repairing bedding cracks of asphalt pavement and cracks of semi-rigid subgrade base; 3) new and widening asphalt pavements. The related performance indexes are as table 4:

Table 4 Physical and Chemical characters of GBF basalt fiber reinforced polyester anti-cracking geotextile

Property		Unit	Index
Areal density		g/m ²	120-150
Thickness		mm	0.65-1.0
Thermal endurance		°C	≥230
Breaking strength	Longitudinal	N/5cm	≥360
	Transversal	KN/m	≥6
Break elongation	Longitudinal	%	≤4
		Transversal	

The working temperature range of basalt fiber is wide (-269~650°C). When together with asphalt under high temperature, it won't be influenced by asphalt. High tensile strength and modulus of geotextile can improve the properties of strength and toughness increase. Good chemical stability and ageing resistance can make basalt fiber geotextile as stress absorption layer, thermal insulating layer and waterproof layer, which are exclusively applied in asphalt pavement, like new pavement and old one's maintenance. This can prevent radial cracks of asphalt pavement efficiently and extend service life. Low hygroscopicity, good water permeability and sludge blocking preventing make the basalt fiber geotextile as inverted filter material, which is used in stone filters from levee, river & coast, and filters of slope and retaining wall, allowing water and air to pass freely. Close interspaces of basalt fiber geotextile can prevent neighboring different soil or fillers from mixing. This is applied in different structure layers separation in road, levee and refuse landfill. Thus, in building road, highway, hydraulic engineering, dock project and reforming ground, geotextile not only can improve the project quality, but also extend service life. It has huge economic benefits.

3. Brief summary

As a new type of fibers, basalt fiber has good cost performance, widely used in structural strengthening and repairing, reinforced asphalt and cement concrete pavements. Since the industrialized period is less than 6years, basalt fiber is developed into many fields. It is really innovative and commercial opportunities for new material and product updating via basalt fiber used in nonwoven fabrics. More researches and spreads are needed by more enterprises, research institutions and scholars.

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